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Identifying constraints of bio-fertilizer adoption *(Azospirillum* and *Azotobacter* bacteria) by corn farmers of Shoushtar Township, Iran

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Key words: Bio-Fertilizer, Adoption, Corn Farmers, Shoushtar Township.

Abstract

Use of bio-fertilizers is one of the important components of nutrient management, as they are renewable source of plant nutrients to supplement the chemical fertilizers for sustainable agriculture. This study is aimed at identifying the constraints of bio-fertilizer adoption *(azospirillum* and *azotobacter* bacteria) by corn farmers of Shoushtar Township, Iran. The methodology of this research is non experimental (descriptive) and correlation. Geographic area of this study includes the Shoushtar Township and it has been done in 2013.The population of this study included all corn farmers in Shoushtar Township, Khouzestan province, Iran. The sample size according to the Cochran equation was 148. The farmers were classified into two categories of adopters, and non-adopters. A questionnaire, as the main study tool, was designed in seven sections. Content and face validity were established by a panel of experts. A pilot study was conducted with 30 persons. Computed Cronbach Alpha score was 83.5%, which indicated that the questionnaire was highly reliable. Based on the results, lack of education and extension practices was considered as the important factor for non-usage bio-fertilizers in the farming practices. The lack of knowledge of experts about bio-fertilizers was the second reason for non-adoption. Based on the logit model, correctly predicted 73 percent of the adopters and non-adopters. The analysis indicated that the following farmers' personal, economical and social characteristics were positively and significantly related to the adoption: Educational level, farm size, accessibility, attitude to natural conservation, on farm income, off farm income and social participation.

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Introduction

Bio-fertilizers can be expected to reduce the use of chemical fertilizers and pesticides. The microorganisms in bio-fertilizers restore the soil's natural nutrient cycle and build soil organic matter. Through the use of bio-fertilizers, healthy plants can be grown, while enhancing the sustainability and the health of the soil and water (Astaraee and Koochaki, 2006).Bio-fertilizer is a technological innovation that has the potential to increase crop yield, reduce production cost and improve soil condition. The efficacy and income effect of bio-fertilizer application have been proven by many field trials and impact assessment studies (Chupungco and Paunlagui, 2004; FNCA, 2007; Baconguis *et al*, 2012). Use of bio-fertilizers is one of the important components of nutrient management, as they are renewable source of plant nutrients to supplement the chemical fertilizers for sustainable agriculture (Sood, Sharma and Singh, 1993). The role and importance of bio-fertilizers in sustainable crop production has been analyzed and reported by several researchers (Barik and Goswami, 2003., Katyal *et al*., 1994., Wani and Lee, 1992., Kumari and Lakshmi2009; Kalaigandhi *et al*., 2010; Kanimozhi and Panneerselvam, 2011). Using bio-fertilizers that contain different microbial strains has led to a decrease in the use of chemical fertilizers and has provided high quality products free of harmful agrochemicals for human safety (Mahfouz and Sharaf-Eldin 2007., Rahimi, Mashayekhi, Amini and Soltani, 2009).

Chamangasht *et al* (2012) indicated that inoculating seeds with the bio-fertilizers significantly increased plant height, the number of leaves, biomass, leaf area index and plant yield, compared with the control (no bio-fertilizer). Generally, Azospirillum was the best treatment studied in this experiment with the highest value of the measured traits. It increased plant biomass by 43.96% compared with the control. Azotobacter and Azospirillum bacteria could be a beneficial source to enhance plant growth and produce considerable amounts of biologically active substances that can promote growth of reproductive organs and increase the plants' productivity (Zahie, Arshad and Frankenberger, 2004). Inoculation of maize and wheat seeds with Azotobacter and Azospirillum increased plant growth nutrient uptake and yield (Kouchebagh, Mirshekari and Farahvash, 2012). *Azospirillum* and *Azotobacter* have been used in agricultural systems as bio-fertilizer for their beneficial effects on plant growth (Tilak *et al*., 1982). Dobbelaere *et al* (2001) showed *Azotobacter* and *Azospirillum* increased plant growth, nutrient uptake and yield. **Biari, Gholami and Rahmani (2008) reported** *Azospirillum* and *Azotobacter* had positive effects on yield and growth parameters of corn under field conditions. Based on the results all bacterial inoculations caused significant increase on growth parameters, such as shoot dry weight, ear and seed dry weight. The results showed the *Azospirillum lipoferum* s-21 had the most effect on ear and seed dry weight.

Azotobacter and *Azospirillum* are known as non symbiotic free living nitrogen fixing bio-fertilizer microorganisms which actively participate in nutrients cycles. In eastern Uttar Pradesh of India, there is a great diversity in various cropping systems that may possess variation in these important bio-fertilizer microorganisms (Maurya *et al* , 2012).

Peng *et al* (2013) showed that organic fertilizers in the form of N-fixing Azotobacter enhanced bio-fertilizer increased yield with positive effects on measured plant height, weight and leaf index. Given the significant enhancement in growth and yield of corn taking place mainly with N-fixing Azotobacter fertilizers under organic condition, the mechanism for this beneficial effect could be due to the more balanced nutrition and improved absorption of nitrogen and other mineral nutrients by the corn.

Van Oosterom *et al* (2010) revealed that effect of nitrogen fertilizer on stem growth of sorghum was significant. Empirical studies identify numerous variables as being important to a household's decision

to use a new technology. The underlying characteristic of these variables is that they are hypothesized to affect the demand for the technology. Overall, the factors that affect a household's decision to use a new technology such as fertilizer fall into three broad categories: market price and economic profitability-level variables, household level variables, and physical and geographical-level variables (Knepper, 2002). Education of the household head is assumed to have an important, positive impact upon the adoption and use of new technologies (Nkonya *et al*, 1997). Farm size will generally have a positive impact on a household's decision to adopt and use a new technology such as fertilizer (Kherallah *et al*, 2001). Off-farm income is typically seen as significant in the decision of households touse new technologies (Feder *et al*, 1985). Kherallah *et al* (2001) conclude that market price of fertilizer had a negative effect, as economic theory would suggest, on fertilizer use. Some of researchers such as Shakya and Flinn (1985) report transportation costs may also significantly affect fertilizer use. Sundaravardarajan *et al* (2006) revealed that educational level, farm size and availability of technology had a significantly effect on bio-fertilizer use.

Based on these issues, the study was aimed at identifying situation of reduction in chemical fertilizers due to usage of bio-fertilizers and determining constraints of biological fertilizer adoption (Azospirillum And Azotobacter Bacteria) by corn farmers

Materials and methods

Method of research

This is applied study. The methodology of this research is non experimental (descriptive) and correlation. Geographic area of this study includes the Shoushtar Township and it has been done in 2013.The population of this study included all corn farmers in Shoushtar Township, Khouzestan province, Iran. The sample size according to the Cochran equation was 148. The farmers were classified into two categories of adopters, and non-adopters. A sample of 113 non-adopters and 35 adopters was interviewed with the help of well-structured, pre-tested interview schedule. Multistage stratified sampling procedure was employed for drawing samples.

Study tool

A questionnaire, as the main study tool, was designed in seven sections. Constraints of adoption, reasons for preferring bio-fertilizers to chemical methods, social factors, economical factors, policy making factors, educational factors, and the respondents` personal characteristics were included in the first to the seventh section, respectively. Content and face validity were established by a panel of experts consisting of faculty members and some specialists in the mentioned province. Minor wording and structuring of the instrument were made based on the recommendation of the panel of experts. A pilot study was conducted with 30 persons who had not been interviewed before the earlier exercise of determining the reliability of the questionnaire for the study. Computed Cronbach Alpha score was 83.5%, which indicated that the questionnaire was highly reliable. Totally, Cronbach`s coefficient alpha for the study tool was between 0.71 and 0.96.

Results

This study is aimed to identify the constraints of bio-fertilizers adoption in Shoushtar Township and its results are evaluated in two descriptive and deductive sections.

Description of personal characteristics

According to results, average age of the studied farmers was 49.8 years; the youngest was 25 and the oldest was 79 years. Based on educational levels, a greater proportion of them had 1-5 year education level. Their average work experience was 20 years. A sample of 113 non-adopters and 35 adopters was interviewed with the help of well-structured, pre-tested interview schedule.

Table 1. Demographic profile of corn farmers.

variables	Frequency	Percentage	Cumulative Percentage	
Age				
25-35	12	8.11	8.11	
36-45	35	23.65	31.76	Mean=49.8
46-55	51	34.46	66.22	Sd= 9.12
55-65	23	15.54	81.76	Min=25
65-75	21	14.19	95.95	Max=79
75-85	6	4.05	100.00	
Adoption rate				
Non-Adopter	113	76.35	76.35	
Adopter	35	23.65	23.65	
Educational level (Year)				
1-5	64	43.24	43.24	
6-9	46	31.08	74.32	Mean=4.5
9-12	24	16.22	90.54	Sd=1.73
12<	14	9.46	100.00	
work experience (Year)				
1-10	34	22.97	22.97	
11-20	59	39.86	62.84	Mean=20
21-30	55	37.16	100	Sd=10.11

Reduction in Chemical Fertilizers due to Usage of Bio-fertilizers

Reduce rate of chemical fertilizers due to use of bio-fertilizers was measured and adopters were grouped under three classes, 1: between 0 to 15 per cent, 1: 15 to 30 per cent, and 3: >30 per cent of their normal fertilizer schedule. The details of the percentage analysis are given in Table 2. According to the results, due to the use of bio-fertilizers, respectively, 51.43 and 42.86 percent of farmers had over 30% reduction in use of nitrogenous and phosphatic fertilizers.

Table 2. Frequency of farmers about reduction in chemical fertilizers due to usage of bio-fertilizers.

Chemical fertilizers	< 15 per cent		15 to 30 per cent		>30 per cent	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Nitrogenous fertilizers	5	14.29	12	34.29	18	51.43
Phosphatic fertilizers	6	17.14	14	40	15	42.86

Constraints of Biological Fertilizer Adoption (Azospirillum And Azotobacter Bacteria) by Corn Farmers

The constraints the adoptions of bio-fertilizers by the non-adopters were ranked and the results have been presented in Table 3. Based on the results, lack of education and extension practices was considered as the important factor for non-usage bio-fertilizers for usage bio-fertilizers in the farming practices, as perceived by the non-adopters (Mean: 4.12, sd: 1.01). The lack of knowledge of experts about bio-fertilizers was the second reason for non-adoption (Mean:4.11, sd: 1.02). The lack knowledge and awareness about bio-fertilizers was the next reason for non-adoption (Mean:4.09, sd: 1.03).The problem of time-consuming use of bio-fertilizers was given the least importance (thirteen reason) (Mean: 3.23, sd: 1.26).

Reasons for Using Bio-Fertilizers than Chemical Fertilizers

The reasons for preferring the using bio-fertilizers than chemical fertilizers were ranked as per the adopters' preference and the results are presented in Table 4. Farmers have opted using bio-fertilizers due to increase food security and accordingly, they ranked it as the first reason (Mean:4.12; sd: 1.07) for selecting it over chemical pesticides. Similarly, the soil and water pollution could be very well reduced by this method and hence, it was ranked as the second reason (Mean: 4.02, sd: 1.07). The avoid endangering human health

and natural ecosystems was the next reason for usage of bio-fertilizers (Mean:3.45, sd: 0.92).

Table 3. Ranking constraints of biological fertilizer adoption *(azospirillum* and *azotobacter* bacteria) by corn farmers.

Constraints	Mean	sd	CV	Rank
Lack of government support	4.02	1.09	0.271	6
Lack of education and extension practices	4.12	1.01	0.245	1
Time-consuming use of them	3.23	1.26	0.391	13
Lack of knowledge of experts	4.11	1.02	0.247	2
Lack of availability of them	3.98	1.24	0.312	7
Lack knowledge and awareness	4.09	1.03	0.251	3
Require many Labor	3.45	1.11	0.321	8
Not using by others	3.54	1.24	0.35	10
Bio-fertilizers are expensive	3.37	1.13	0.334	9
Less effective than chemical fertilizers	3.24	1.17	0.361	11
Unfamiliarity with use of them	4.1	1.05	0.256	4
Lack of belief in use of them	3.34	1.26	0.378	12
Lack of demonstration farms	4.05	1.07	0.265	5

1: Very low; 2: Low; 3: Moderate; 4: High and 5: Very high

Table 4. Ranking reasons for preferring the using bio-fertilizers than chemical fertilizers.

Constraints	Mean	sd	CV	Rank
Reduce soil and water pollution	4.02	1.07	0.265	2
Increase food security	4.12	1.05	0.256	1
Convenience and ease of use	3.23	0.95	0.295	5
Availability and low cost	4.11	1.25	0.305	7
Cost effectiveness	3.98	1.21	0.304	9
Prevent the loss of soil organisms	4.09	1.25	0.306	8
Avoid endangering human health and natural ecosystems	3.45	0.92	0.267	3
Sustainable Management of Natural Resources	3.54	1.07	0.301	6
Improve the quality and quantity of the product	3.37	0.98	0.29	4

1: Very low; 2: Low; 3: Moderate; 4: High and 5: Very high

Implications of Logit Model on Bio-fertilizers Adoption

The extent of adoption of bio-fertilizers is influenced by personal, economic and social factors. Normally, probability models are employed to understand personal and socio-economic factors determining the extent of adoption of bio-fertilizers. In this research, multi-nominal logit model was employed to assess the probability of overall extent of adoption of bio-fertilizers by the farmers.

The model resulted of table 5, has been significant at one percent level based on the log-likelihood ratio test. The model correctly predicted 73 percent of the adopters and non-adopters. The analysis indicated that the following farmers' personal, economical and social characteristics were positively and significantly related to the adoption: Educational level, farm size, accessibility, attitude to natural conservation, on farm income, off farm income and social participation.

Table 5. Non-linear estimates of bio-fertilizers adoption.

Variables	Estimates
Educational level	0.93** (3.12)
Market price	-0.89**(3.08)
Farm size	1.02**(3.45)
Availability	0.68 (0.89)
Accessibility	1.21** (2.21)
Attitude to natural conservation	1.05**(3.61)
Age	0.54 (0.82)
On farm income	1.34** (3.27)
Off farm income	1.22**(3.05)
Social participation	1.28**(3.35)
Constant	10.12* (1.89)
Log-likelihood ratio	16.56** (7.45)
Count R^2	0.73

Note: Fig.s within the parentheses are asymptotic 't' ratios with respect to log likelihood ratio denoting χ^2 value

***P < 0.01 (two-tailed test)

**P < 0.05 (two-tailed test)

*P < 0.1 (two-tailed test)

Discussion

Based on the results, educational level was positively and significantly related to the bio-fertilizers adoption. Nkonya *et al* (1997) and Shahidi Zandi (1997) have confirmed the role of educational factors in the technology adoption. In addition market price negatively and significantly related to the bio-fertilizers adoption. Kherallah *et al* (2001) confirmed the role of market price in the technology adoption. Also the farm size level was positively and significantly related to the bio-fertilizers adoption. Kherallah *et al* (2001) has confirmed the role of farm size in the technology adoption. Based on the results the attitude to natural conservation was positively and significantly related to the bio-fertilizers adoption. Ommani *et al* (2009) has confirmed the role of farm size in the technology adoption. As another result, the on farm and off farm income were positively and significantly related to the bio-fertilizers adoption. Feder *et al* (1985) has confirmed the role of farm size in the technology adoption. The social participation positively and significantly related to the bio-fertilizers adoption. Ommani *et al* (2009) has confirmed the role of social participation in the technology adoption.

Conclusion

According to the results, due to the use of bio-fertilizers, respectively, 51.43 and 42.86 percent of farmers had over 30% reduction in use of nitrogenous and phosphatic fertilizers.

Based on the results, lack of education and extension practices was considered as the important factor for non-usage bio-fertilizers for usage bio-fertilizers in the farming practices. The lack of knowledge of experts about bio-fertilizers was the second reason for non-adoption.

Farmers have opted using bio-fertilizers due to increase food security and accordingly, they ranked it as the first reason for selecting it over chemical pesticides. Similarly, the soil and water pollution could be very well reduced by this method and hence, it was ranked as the second reason. Based on the logit model, correctly predicted 73 percent of the adopters and non-adopters. The analysis indicated that the following farmers' personal, economical and social characteristics were positively and significantly related to the adoption: Educational level, farm size, accessibility, attitude to natural conservation, on farm income, off farm income and social participation.

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